Proceedings of the Iowa Academy of Science

Volume 40 | Annual Issue Article 33

1933

The Dielectric Constant and Specific Conductance of Liquid Hydrogen Sulphide at 194.5° K

W. G. Bickford
Iowa State College

J. A. Wilkinson
Iowa State College

THE DIELECTRIC CONSTANT AND SPECIFIC CONDUCTANCE OF LIQUID HYDROGEN SULPHIDE AT 194.5° K

W. G. BICKFORD AND J. A. WILKINSON

The following values have been reported for the specific conductance of liquid hydrogen sulphide.

0.1×10^{-6} ohm^{-1} cm^3 — a-c method — Steel, McIntosh & Archibald [1] less than 4×10^{-7} ohm^{-1} cm^3 — d.c. method — Magri[2]

1×10^{-11} ohm^{-1} cm^3 — d.c. method — Quam & Wilkinson [3]

3.7×10^{-11} ohm^{-1} cm^3 — d.c. method — Satwaleker, Butler & Wilkinson [4]

The following values have been reported for the dielectric constant of liquid H_2S.

10.2 — audio frequency — magri [2]

9.4 — Radio frequency — Kemp and Dennison[5]

The disagreement in the data as cited in the first three references led Satwaleker, Butler and Wilkinson to redetermine the value for the specific conductance in 1930. Their value is probably the most accurate of those so far published, for they realized the importance of working at low voltages, and discovered the effects that traces of moisture have upon the conductance of the liquid.

However, their value is open to question because (1) they employed a direct current with no compensation for polarization other than platinization of the electrodes. (Their data show that polarization was influencing the resistance being measured).

(2) Their reported value is uncorrected for the conductance of the empty cell, which in their case may have been appreciable. The resistance of a cell exerts a marked shunting effect upon poorly conducting substances.

(3) The liquid H_2S used may have contained traces of H_2O, AsH_3, and CO_2.

In this investigation, polarization was reduced by the use of alternating current at 995 csp. and its effect was compensated in the bridge net work used. The shunting effect of the cell was

1 Steel & Coworkers — Phil. Trans. Soc. 205 A 99 (1906).
2 Magri — Atti Accad. Linceu (5) 16, I, 510 (1907).
3 Jour. Am. Chem. Soc. 47, 989 (1925).
4 *Jour. Am. Chem. Soc. 52, 3045* (1930).

determined and allowed for in the calculations. The purity of the H_2S was insured by a special method of preparation, and by fractional distillation.

The most probable value in earlier work on the dielectric constant is that of Kemp and Dennison,[5] since they used an improved bridge method.

The bridge that we have employed is a modification of the Wien Bridge, and the method of comparing the test cell was that of R. F. Field.[6] This method incorporates several distinct advantages.

The bridge net work consists of the following units: (1) A double balanced harmonic free Eccles & Jordan audio-frequency oscillator.[7] (2) A transformer-resistance coupled multistage amplifyer. (3) An equal ratio arm mixed-impedance bridge. (4) A Wagner Earthing device. (5) Impedance matching interbridge transformers of astatic construction. (6) Individual shielding of all the component parts of the net work.

A type 222 L Gen. Radio Precision Condenser calibrated to O.luμF, and resistors accurate to $\pm$ 0.02% were used as the balancing standards.

The measuring cell consists of 3 concentric platinum electrodes, the outer and inner electrodes are joined together and maintained at earth potential in the net work for shielding purposes. Its inter-electrode capacitance is 47.8 uμF and the constant is 1.85×10^{-3}. It was designed in accordance with the recommendations of Jones and Bollinger [8] for conductance cells.

The equivalent parallel resistance of the cell filled and empty was determined by the series condenser method.[9]

(1) The H_2S was prepared by treating a saturated solution of $MgCl_2$ with solid CaS and heating to 60° C. It was washed with H_2O, $Ba(OH)_2$, then passed through $CaCl_2$ and P_2O_5 chambers. It was then liquified at atmospheric pressure by means of a CO_2 - ether bath, and finally fractionally distilled into the measuring cell. The apparatus was all of glass (Pyrex) sealed together with no rubber connections.

The constants proposed for liquid H_2S at 194.5° K are.

Specific conductance 1.17×10^{-9} ohm^{-1} cm^3.

Dielectric constant 8.3_7.

The dielectric constant was determined by the usual procedure

5 Kemp & Dennison — Jour. Am. Chem. Soc. 55, 251 (1933).
6 R. F. Field — Gen. Radio Exp. 8 Jan. (1930).
7 We are very much indebted to Dr. Theo. Shedlovsky of the Rockefeller Inst. for Med. Res. for furnishing us with detailed information about his improved oscillator. See Jour. Am. Chem. Soc. Vol. 52, page 1793. (1910.
8 Jones & Bollinger, Jour. Am. Chem. Soc. 53, 411 (1931).
9 See Hague — "A. C. Bridge Methods" Page 136, for example.

of taking the ratio of capacities of a condenser empty and filled, and proper corrections were made for lead capacities, as well as for earth capacities of the test condenser.

DEPARTMENT OF CHEMISTRY,
IOWA STATE COLLEGE,
AMES, IOWA.